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Research Paper

Correlation of Corneal endothelial loss to corneal curvature and axial length in Phacoemulsification

Medical Science

KEYWORDS : Microcoaxial Phacoemulsification, Endothelium, corneal curvature, Axial length

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ABSTRACT

Background: *Phacoemulsification is widely used cataract surgery. Corneal endothelial loss is an issue in predisposed eyes.*

Methods: *In this prospective observational study, 87 eyes of 87 patients who underwent phacoemulsification were included. The corneal endothelial cell count, central corneal thickness and coefficient of variance were assessed preoperatively and postoperatively after 1, 6 and 12 weeks of surgery. The corneal endothelial cell loss was correlated to patient's age, corneal curvature and axial length.*

Results: *The mean age was 61±9.68 years. Statistically significant endothelial cell loss was noted (P<0.000) at 12 weeks with mean endothelial cell loss of 11.6%. Eyes with shorter axial length and corneal curvature had significantly more endothelial loss (P=0.04 and P=0.02). Central corneal thickness did not return to normal value at 12 weeks (P<0.000).*

Conclusion: *Phacoemulsification is associated with acceptable endothelial loss and it correlates with older age, lesser corneal curvature and short axial length.*

Introduction

Cataract surgery is one of the most frequently performed eye surgery. It has come a long way with refinement in technique of phacoemulsification (Olson et al 2003). Corneal endothelial damage has been a main concern in cataract surgery as it influences the successful outcome of the surgery. The endothelial loss has been attributed to preoperative and intra operative factors such as ultrasonic energy, increased phaco time, excessive manipulation, type of viscoelastic used, type of Intra Ocular Lens (IOL) implanted etc. (Dholakia and Vasavada, 2004).

Phacoemulsification is a standard cataract surgery performed worldwide these days. The advantages offered include smaller incision size, sutureless procedure, lesser recuperative period, early visual rehabilitation and lesser astigmatism. The size and location of corneal incision in phacoemulsification affects the postoperative astigmatism and therefore the postoperative visual outcome (Alió, 2006). In recent years there has been increased effort to reduce the size of corneal incision and postoperative astigmatism by micro-coaxial phacoemulsification. We therefore conducted a prospective comparative study of patient risk factors for endothelial cell loss after uneventful micro-coaxial phacoemulsification surgery through 2.2mm incision.

Methods

The study was conducted over a period of 12 months in the department of Ophthalmology at Himalayan Institute of Medical Sciences, Dehradun, India. The study was approved by the local research and ethics Committee and written informed consent was obtained from each patient after explanation of the nature of the study. All patients of senile cataract between the age of 40-80 years with nucleus sclerosis of grade 3 and grade 4 on Lens Opacities Classification System III (LOCIII) were included for surgery (Chylack et al 1993).

Exclusion criterion included (1) patients under the age of 40 and over 80; (2) types of cataract other than age-related; (3) preoperative endothelial count less than 1500 cells/mm^2; (4) previous intraocular and refractive surgery (5) patients of glaucoma; (6) patients with axial length over 26 mm; (7) corneal curvature more than 48Diopters and less than 39Diopters, (8) and patients with nucleus sclerosis grade 5 or 6 on LOCIII; (9) any condition that impeded corneal evaluation by specular microscopy and pachymetry(10) effective phacoemulsification time more than 10seconds and (11)any intraoperative complication.

Preoperative examinations

All patients underwent a complete ocular examination, IOL power calculation, and an endothelial cell count (EC) preoperatively (preopEC) and postoperatively at 1 week, 6week and 12 weeks (postopEC). Keratometric power was obtained using a manual keratometer (Bausch and Lomb, Rochester, NY) and axial length was measured using an ultrasonic A-Scan (Alcon Laboratories). The power of the IOL was calculated in all the patients using SRK-T (Sanders, Retzlaff, and Kraff) formula. The cataract was graded according to the LOCS III. IOP was recorded using applanation Goldman tonometer. Evaluation of posterior segment was done using +90D biomicroscopy and indirect ophthalmoscopy

Central corneal pachymetry and central corneal endothelial cell density was determined by SP-2000P noncontact specular microscope (Topcon America Corporation, Paramus, NJ). Corneal endothelial cell density (cells/mm2) was calculated by analyzing minimum of 40 cells in the central cornea preoperatively and postoperatively on subsequent follow up as per protocol.

Surgical technique

Eighty seven eyes of 87 patients underwent microcoaxial phacoemulsification. All eyes were dilated preoperatively with tropicamide and phenylnephrine eyedrops. All surgeries were performed under peribulbar anaesthesia using 2.5ml of lignocaine and 2.5ml of bupivacaine with 150 units of hyaluronidase. Surgery was done through 2.2mm clear corneal incision using Zeiss Visalis 100 phacomachine. Incision was located in superotemporal quadrant in right eye and superonasal quadrant in left eye. Single piece acrylic hydrophobic lens was implanted in the bag in all patients. All surgeries were done by two surgeons HB and RD, using direct chop technique described elsewhere[7].

The percentage of postoperative endothelial cell loss (ECL%) was calculated as follows:

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$$ECL\ (\%) = \frac{preopEC - postopEC}{preopEC} \times 100,$$

where ECL% is the percentage of postoperative endothelial cell loss, preopEC is the preoperative corneal endothelial cell count, and postopEC is the postoperative corneal endothelial cell count 12 weeks postoperatively.

Corneal endothelial loss in the eyes was studied on the basis of corneal curvature and axial length in the study group. The data thus collected was subjected to standard statistical analysis by SPSS version 16 software (SPSS Inc. Chicago, USA). The normality of data was tested. As the data was homogenous and normally distributed one way ANOVA was used among groups and paired t-test was used within groups. Correlations among parameters were evaluated utilizing Pearson tests. P-values <0.05 were considered statistically significant.

Results

Eighty seven patients with cataract were consecutively recruited. Of the total 87 patients, 48 were males and 31 were females with male: female ratio of 1.2:1. The mean age was 61±9.68 years. The mean corneal curvature of the study group was 44.61±1.76 D and the mean axial length was 24.11±1.29mm. The nucleus sclerosis was grade 3 in 52.87% and grade 4 in 47.1% patients. The effective phaco time in the study group was 5±2.3s.The mean preoperative visual acuity was 0.70±0.45 Log MARs and at 6 week postoperative was 0.22±0.15 Log MARs. A significant improvement in the visual acuity was noticed in the study group with a P value < 0.000 by paired t test.

Post operative endothelial loss and age

In the current study group the mean preopEC was 2358±403.8 cells/mm^2 and at 12 weeks the mean postopEC was 2083± 406 cells/mm^2. The mean postopEC loss was 275.6±48. The total percentage of ECL% was 11.69% at 12 weeks. The postoperative endothelial loss in the study group was highly statistically significant (P <0.001). Figure 1 shows endothelial loss in different age groups. The endothelial loss in the older age was statistically significant (r=-0.21 P=0.008).

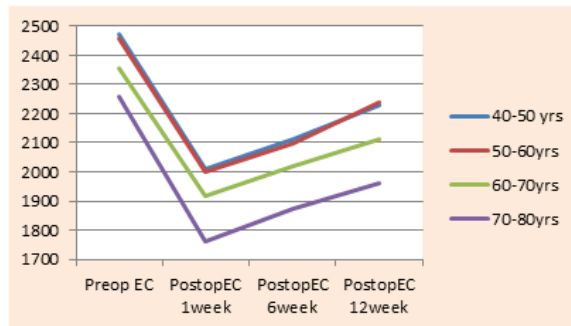

Figure 1. Endothelial loss according to age

Post operative endothelial loss, axial length and corneal curvature

Table 1 shows preopEC and postopEC at 1week, 6 week and 12 weeks according to axial length. The postopEC loss was more in patients of shorter axial length (P=0.04). In the current study group there was correlation between axial length and corneal curvature (r=-0.27, P<0.004). Table 2 shows the preopEC and postop EC at 1 week, 6 week and 12 weeks according to corneal curvature. There was increased corneal endothelial loss in patients of flatter cornea (P=0.02).

Table 1. Axial length and postoperative endothelial loss

Axial length	PreopEC	PostopEC 1 week	PostopEC 6 weeks	PostopEC 12 weeks	Loss of cells
20-23mm (n = 39)	2494 ±413.3	1868±397	2005±363	2114±410	304 (12.62%)
23-26mm (n =48)	2310±388	1898±407	1976±375	2057±393	253 (10.95%)

Abbreviations: Preop EC Preoperative endothelial count; Postop EC Post operative endothelial count.

Table 2. Corneal Curvature and postoperative corneal endothelial loss

Corneal Curvature	PreopEC	PostopEC 1 weeks	PostopEC 6 weeks	PostopEC 12 weeks	Loss of cells
39-42 D (n=31)	2277±403	1820±373	1893±382	1970±374	307(13.5%)
43-45 D (n=37)	2354±398	1867±423	2001±396	2094±418	260(11.04%)
46-48 D (n=19)	2499±409	2024±392	2123±372	2244±395	255(10.2%)

Abbreviations: Preop EC Preoperative endothelial count; Postop EC Post operative endothelial count.

Post operative endothelial loss and corneal thickness

The preoperative mean central corneal thickness was 0.515±0.043 mm and mean coefficient of variance was 28 ± 8.05. The cornea showed an increased thickness, at 1week post op (0.562±0.57mm). The change in corneal thickness at one week was statistically significant (P<0.000). The central corneal thickness was still increased from baseline by 0.008 mm at 12 weeks follow up. This was statistically significant by one way ANOVA (P<0.000). There was a minimal change in coefficient of variance at post op 6 weeks (28.81±6.5) showing that the uniformity of the shape of cells was maintained and it was not statistically significant (P=0.48).

Discussion

Corneal endothelium maintains the normal transparency of the cornea by its active fluid pump. The natural loss of human endothelial cells is approximately 0.6% each year (Bourne et al 1997). Intraocular surgeries like phacoemulsification do however cause fluid and lens fragment turbulence that can lead to endothelial cell damage (Dick et al 1996). Corneal endothelial alterations are considered important parameter of surgical trauma and are also essential for estimating the safety of surgical techniques and of course the visual outcome of the patient.

In the current study various preoperative factors of the patients were studied. The mean preoperative visual acuity was 0.70±0.45 LogMARs. The mean 6 week postoperative visual acuity was 0.22 ± 0.15 LogMARs. Eyes in which there was prolonged phaco time or intraoperative complication were excluded.

Past reports have shown several preoperative and intra-operative factors, which may influence the risk of endothelial cell loss after phacoemulsification (Walkow et al 2000, Hayashi et al 1996). In recent studies on microcoaxial phacoemulsification, endothelial loss varied from 6.52 to 15.4% (Mandy et al 2012, Franchini et al 2008). In the current study the mean endothelial loss was 11.6% which is in accordance with studies available in literature. In this study group the nucleus sclerosis of grade 4 was present

in 47.1% cases. Despite increased proportion of nucleus hardness in the study group the mean endothelial loss was within acceptable limit showing the efficacy of microcoaxial phacoemulsification.

Preoperative factors such as short axial length, short anterior chambers and patient's age have been studied as risk factors for predicting endothelial loss. In literature some reports show no correlation between short axial length and shallow anterior chamber to increased risk of endothelial cells loss (Pereira et al 2006, Cho et al 2010). In contrast to this, in the current study short axial length and increasing age of the patient correlated with increased corneal endothelial loss at 3 months.

It is well established that the corneal endothelium changes as a function of age. In most individuals, the cell density decreases from birth to death. This leads to polymegathism and pleomorphism, making the endothelium more vulnerable to injury and loss of cells in old age (Bourne et al 1997). Walkow et al (2000) and Hayashi et al (1994) showed positive correlation between short axial length and shallow anterior chamber to postoperative endothelial loss. They postulated that a greater distance between the phaco tip and the endothelium in longer eyes, or greater relative variations in axial length compared to anterior chamber depth can reduce endothelial loss in myopic eyes.

One of the other parameter studied in this study was the correlation of corneal endothelial loss to corneal curvature of the study group. We found a significant correlation between the corneal curvature and loss of endothelial cells. Eyes with lesser corneal curvature had more endothelial loss in the current study. There was also a correlation of axial length to corneal curvature.

A correlation between myopia and steep central corneal has been reported in literature (Carney et al, 1997). Patients with myopia therefore have deep anterior chamber. Similarly flatter cornea has been associated with shorter axial length. This probably explains the greater loss due to the shallower depth of the anterior chamber. The space for manipulation and instrumentation is lesser in these patients leading to more injury to the endothelium (Ko et al, 2004).

In the current study we found that though there was postoperative corneal endothelial loss, the endothelial cells showed a minimal change in coefficient of variance. This shows that the uniformity of the shape of cells was maintained despite endothelial trauma from surgery. Similar results have been seen in other studies (Ko et al, 2008).

Cornea shows transient increase in thickness due to surgical trauma (Lundberg B et al, 2005). In the current study the corneal thickness increased at 1 week postoperative follow up. This increased corneal thickness was statistically significant. The cornea takes months to return back to its state of normal thickness after undergoing cataract surgery. The duration of follow up in our study is only 12 weeks. It was the possible reason for the failure of return to normal thickness at the last follow up. However, the mean central corneal thickness showed a progressive decrease towards normality with time.

To conclude we have observed that microcoaxial phacoemulsification is safe procedure even in hard cataracts. Shorter axial length, increasing age and lesser corneal curvature presents with the increased risk of endothelial cell loss. The effect of these three factors is not however cumulative. It is recommended to take extra precautions while performing surgery in older patients, those with shorter axial length and lesser corneal curvature.

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